

**PEER REVIEW OF NOAA PROTOCOLS FOR GROUND FISH BOTTOM
TRAWL SURVEYS OF THE NATION'S FISHERIES RESOURCES**

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EXECUTIVE SUMMARY

This independent peer review covers the protocol document prepared by G. Stauffer, Leader of Trawl Survey Protocol Development, Alaska Fisheries Science Center (AFSC) under the requirements of Admiral Lautenbacher's December 16, 2002 memo. The current protocols and directives regarding trawl survey operations are the result of the National Trawl Survey Standardization Workshop convened in Seattle, 13-15 November 2002, which reviewed the old standard protocols to determine what changes were needed. The objective of the independent review is to closely examine the revised NOAA protocols to "ensure that all aspects of preparation for trawl surveys and trawl survey procedures are consistent and in keeping with the highest quality standards to provide for survey accuracy and consistency from one survey to the next within all Science Centers."

I fully agree and support the five protocols and three recommendations. In examination of each Science Center's new manual of protocols, I found several inconsistencies. I have made seventeen recommendations and numerous comments in the report. These should be addressed to achieve a concise, unambiguous set of survey protocols. Some of these recommendations may be achieved by devising national standards; others may be addressed within individual Centers. I endorse the conclusion of the Workshop, which states that the standardization program is a long-term effort requiring continuous review and updating.

Background

Changes in catchability on estimates of stock size, due to changes in trawl geometry and performance, are a major source of uncertainty in trawl surveys. Bias in the form of a systematic error may occur in abundance estimates from bottom survey trawls as a result of changes in the vessel power, vessel emitted noise levels, crew, trawl design, and adherence to trawl construction specifications during fabrication and repairs (Byrne et al., 1982; Walsh et al., 1993). Minimizing these errors to an acceptable level must be a priority in all surveys. Standardization of all survey trawl construction, including procurement of nets and components, repairs and fishing protocols, is expected to contribute to minimize these errors (Walsh et al., 1993; Engås 1994; McCallum and Walsh 1995).

In 1991, an international workshop on survey trawl mensuration was held at the Northwest Atlantic Fisheries Centre, St. John's, Newfoundland, with scientists from Canada, United States (both AFSC and NMFS representatives), Norway, Sweden, Iceland, and the United Kingdom (Walsh et al., 1993). Participants at the workshop identified three main areas that affect and contribute to survey bias and variance: physical performance of vessel and trawl; physical aspects of the survey site, biological aspects related to fish behavior (environment); and human activities prior to and during the survey. All were unanimous in their belief that the standardization of survey protocols could result in significant improvements to trawl surveys by controlling the 'human factor'. In 1992 a report was released by the ICES Working Group on Fishing Technology and Fish Behavior summarizing the findings of a subgroup formed to evaluate sources of variability in the fishing power of the Grand Overture Vertical (GOV) survey trawl used in a multi-country survey of the North Sea (Anon 1992). The working group endorsed the 1991 workshop report and incorporated many of the results from the workshop into its own report on the GOV trawl. Additionally, both reports identified the many factors leading to inconsistent trawl behavior. The following were cited as the most important factors, and which should be monitored and possibly controlled: trawl

construction and rigging (bridles, sweeps, doors and net material); swept area/volume (speed, trawl spread and trawl height); bottom contact; current direction relative to tow duration; and the human factor in gear construction, deployment and retrieval.

One of the main conclusions of both reports was that the “human factors which influence gear deployment, trawl construction, and many other quality control aspects can be controlled through development and implementation of various protocols ranging from purchase and acceptance procedures for new trawls and trawl parts, to gear assessment and tolerances, to training of survey personnel and crew in basics of gear technology and standard fishing practices (Anon 1992).”

The National Trawl Survey Standardization Workshop, which convened in Seattle 13-15 November 2002, was given the directive to “review current protocols and directives regarding trawl survey operation, determine what changes are needed and publish a new protocol.” The objective was to “ensure that all aspects of preparation for trawl surveys and trawl survey procedures are consistent and in keeping with the highest quality standards to provide for survey data accuracy and consistency from one survey to the next.” This workshop developed five protocols for dealing with this issue, of which two deal exclusively with trawl warps, one with standardization of survey procedures (design, set allocations and fishing protocols), one with standardization of trawl construction and repair. The final protocol designated the responsibility for implementing changes in protocols. The report also contained three recommendations for implementation of protocols: 1) wire rope specifications and measurement standard; 2) creation of a NOAA survey standardization working group; 3) training of scientific and vessel staff in trawl construction and repair verification. The report also contained the up-to-date survey procedure manuals of the four Science Centers with the new protocols added.

Description of review activities

After the first reading of the document, I carried out an extensive literature research of related publications and reports to ascertain what has been done in the field and then carried out an extensive second review of the report. The literature in this field of study is limited. The protocols in the workshop report are well developed and critical to the standardization program. I have no further comments directed at these protocols per se. Each center's descriptions of its protocols were examined critically. Sections related to survey design, fishing station allocation, station suitability and search procedures, detailed instructions for initializing and running software routines, catch sorting, sampling and disposal of catch, and routine communications/meetings describing pre-during-post survey preparations (except those related to fishing and fishing gear instrument protocols) were reviewed but not commented upon since many of these are related to sampling methodology and could be the subject of another review itself. Additionally, this review will not deal with Protocol # 5: Changes to Regional Trawl Survey Protocols, which clearly lays out the delegation of responsibility and it is not discussed in any of the Science Center manuals.

I have concentrated on the evaluation of the Workshop protocols and recommendations, and how each Science Center has addressed them in its updated manual. The following critical areas are specifically addressed:

1. Wire rope specifications and measurement standard;
2. Trawl construction, repair and replacement protocols;
3. Trawl standardization programs;
4. Trawl mensuration equipment, and;
5. Standardized fishing operations for each station.

Summary of findings

PROTOCOL 1: LENGTH MEASUREMENT OF TRAWL WARPS

ALASKA FISHERIES SCIENCE CENTER (AFSC)

The AFSC uses four chartered vessels that utilize two different bottom trawl gears, with some variation in footgear riggings. These vessels are involved in four different annual surveys. Three out of the four charter vessels use auto-trawl systems (see Protocol 2).

For all vessels, an inline wire meter will be used to mark warps at sea, and the warps will be measured in real time using a geometric wire meter (AFSC manual: page1).

***Comment:** It is unclear what warp counter is used on the non-auto-trawl vessel.*

The procedure for calibration of warps using in-line meters and a known warp -length (50m) is the most detailed of all Science Center proposals. Marking warps at sea as indicated here is probably the best way to have correct tension on the warps. Offset for measurements of the distance from the gallow blocks to the water surface is built in to the calibration.

***Comment:** Calibration of the geometric wire counters is not discussed. Can they be calibrated with a known length of wire wrapped on the winch? This calibration should be done at least annually. The description needs clarification.*

Annual maintenance by the manufacturer of the in-line meters should be carried out, and this is critical to maintaining an accurate instrument.

***Comments:** Distance between markings on warps is not specified.*

It is noted that tolerance levels will be assessed for each warp and caution taken should each warp measurement exceed the critical value.

Comment: Critical value is 4% as indicated by NOAA protocols

Comment: Trawl warps for charter vessels are to be specified and should include diameter, class, weight (kg/meter) and maximum breaking strain. Are all vessels standardized to one warp? Does each vessel use the same warp specification each year?

Protocols are outlined for circumstances where the metering systems disagree, and appropriate action is specified to resolve the problem

NORTHWEST FISHERIES SCIENCE CENTER (NWFSC)

The center uses four charter vessels using the same trawl type to carry out annual surveys of the West Coast Slope. NWFSC provides each charter vessel with the trawl warps. Pre-cruise marking of warps under tension (not specified) are performed at 25 m intervals using a hand held tape and double checked upon completion. If there is no time available, then the warps are to be measured at sea one at a time with a calibrated in-line meter, and warp is to be attached to the trawl door (presumably in the water). The positions of the marks are double checked at sea. The wire meter is calibrated at least annually using a known wire. The Center also supplies and installs trawl blocks-mechanical warp counters for real time measurement on each vessel.

Comment: During at sea markings, protocols should specify whether the vessel is moving or stationary, and whether the trawl is deployed when using a trawl door to give the necessary load tension.

Comment: Critical value is established at 20.5ft and I am unsure if this equates to 4% as indicated by NOAA protocols, or if perhaps this value has been derived through independent research. This source needs to be clarified.

Comment: Trawl warps for charter vessels are specified, but more detail is needed and should include diameter, class, weight (kg/meter), and maximum breaking strain.

Protocols are outlined for circumstances where metering systems disagree and appropriate action is specified to resolve the problem. Re-calibration of the real-time counter has to be conducted when the warps are remarked after discrepancy.

SOUTHWEST FISHERIES SCIENCE CENTER

The center carries out periodic bottom trawl surveys of the Southern Ocean using a charter vessel equipped with magnetic block wire counters.

Magnetic block wire counters are used and calibrated prior to each survey with a known length of wire passing through the block. A pair of in-line wire counters will be used to validate the readings of the block counters daily.

Comment: Annual maintenance by the manufacturer of the in-line meters should be carried out, as this step is critical to maintaining an accurate instrument. Procedures for annual maintenance should be documented in the manual (see AFSC for an excellent description).

Comment: The critical value used is 5%, and not 4% as recommended by the NOAA standard, moreover, no explanation is given for the discrepancy.

Comment: Trawl warps for charter vessels are specified with correction specifications of diameter, class, weight (kg/meter), and maximum breaking strain.

Protocols are outlined for circumstances where the metering systems disagree, and appropriate action is specified to resolve the problem.

NORTHEAST FISHERIES SCIENCE CENTER (NEFSC)

The NEFSC uses two NOAA owned research vessels to undertake annual surveys to carry out seasonal survey using two different trawls. Trawls warps are procured, installed, and maintained by the Office of Aviation and Marine Operations OMAO.

Wires on both vessels are marked, counted during deployment of trawl, checked for alignment on trawl deck by crew members, and cross- checked with an onboard wire metering system (page 21) on each vessel for each fishing tow.

***Comment:** The type of metering system is not specified, i.e. block counter, geometric counter. Mark distances are specified.*

***Comment:** The critical value used is 4%, as recommended by NOAA.*

***Comment:** Trawl warps for each vessel are specified but not in sufficient detail; they should include diameter, class, weight (kg/meter), and maximum breaking strain.*

Protocols are outlined for circumstances where the metering systems disagree, and appropriate action is specified to resolve the problem.

A separately marked cable is used to verify marks on the wire during rechecking.

PROTOCOL 2: USE OF AUTOTRAWL SYSTEMS

Only the AFSC has vessels that use the auto-trawl system. Three out of four AFSC charter vessels use auto-trawl systems in the dynamic mode that uses onboard standard geometric meters. Real time measurements rely on the geometric wire meters associated with auto-trawl system.

***Comment:** Calibration of auto-trawl system should be carried out before each survey as indicated. It is suggested that a certified auto-trawl mechanic from the manufacturer carry out this calibration.*

General Comment: *The ASC protocols listed for the three auto-trawl vessels and the one non-auto-trawl vessel are somewhat confusing. Under protocol 2 it does not mention the second independent measurement method, which I assume is the same as that mentioned in Protocol 1. It is confusing that the only vessel warp counters mentioned are geometric counters, which one could interpret are used on all four vessels. Is this interpretation of the document correct? Why not break the measurement detail out for both protocols 1 and 2 to remove the ambiguity?*

Summary of observations on Protocols 1 and 2

The minor comments above deal with how each center should clarify its protocols. There are a few discrepancies in the use of the recommended 4% critical value that should be resolved, i.e. NWFSC and SWFSC.

Comment 1: *Protocols are needed to specify when damaged warps should be replaced, or when it is necessary to cut off damaged sections (part of a QC program). The latter action could jeopardize warp calibration procedures if it occurs at sea.*

Comment 2: *From the reviewer's experience, painted marks generally last about 4-6 days on trawl warps. The protocol should include a remarking procedure and schedule it appropriately.*

Recommendation 1: *Service and maintenance of block, geometric, magnetic, and in-line wire counters and auto-trawl systems must be carried out at least once per year by qualified technicians trained and certified by the manufacturer.*

PROTOCOL 3: SURVEY OPERATIONAL PROCEDURES

Factors that affect trawl performance and catchability are addressed here. The objective of this section is to standardize operations to maintain consistency in capture efficiency over time. Emphasis is placed on rigid and unambiguous specifications.

1. Vessel and winch operation during deployment and retrieval

With the exception of NEFSC, which has detailed standardized vessel speeds for net streaming (vessel speed 2-3 knots) and shooting trawl doors/net (6 knots), I assume that the deployment in other Centers is left up to the captain or his designate. SWFSC specifies that the deployment speed should be 0.4 knots higher than the towing speed. The ASFC protocol mentions that at the end of the tow, RPMs are increased in two out of four of its surveys to lift the net off the bottom. The SWFSC manual cites that retrieval speed should be 0.3 knots slower than the towing speed. There is no mention of changes in speed during retrieval by the NEFSC. It may be difficult to recommend a shooting speed because of the differences in winches. Fast shooting speeds minimize door crossing and foul gear. Often the trawl is close to its ideal configuration on contact with the bottom with only a minimal amount of time to reach full configuration.

At the end of the 15 or 30-minute tow, the net should be quickly lifted off the bottom to prevent it to continue to fish on the bottom (Anon 1992). This can be achieved by increasing the towing speed (RPM) to a maximum allowable speed at the beginning of the net retrieval to ‘power lift’ or ‘fly’ the trawl off the bottom. Even when using a power lift at the end of the tow, it can take one minute to get the trawl off the bottom in water depths less than 500 m and three minutes in depths over 1000 m (Walsh and McCallum 1995). This can vary with weather conditions, tow direction and the type of engine in the vessel. The power lift off could be standardized to start at the last minute of the tow. The forward towing speed and hence momentum of the vessel should not be slowed (SWFSC) during net retrieval since doing so will increase the amount of time the net is on the bottom and possibly lead to fish escaping.

Recommendation 2: *AFSC, NWFSC, and SWFSC should revisit their deployment protocols to investigate the option of designated streaming and shooting speeds, and provide analogous specifications to those provided by NEFSC.*

Recommendation 3. *All Science Centers should investigate the amount of time the net continues to fish after haul back begins (TDR and/or BCS data will determine this), and consider specifying standardized power lift-off protocols to minimize extra time fishing at the end of a tow.*

2. Tow duration:

Bottom contact sensors, or TDRs, can be used to establish tow duration more accurately than net-mounted instrumentation currently on the market at the end of each fishing set. There must be enough data from mensuration equipment to establish bottom contact/start of tow criteria for all surveys. A good example of this use of data is the AFSC Gulf of Alaska and Aleutian surveys, which use a standard headline height measurement of 8 m to indicate touchdown and start of tow. However, the other two ASFC surveys do not use a similar criterion. In addition, all four ASFC surveys use bottom contact sensors, but only the Gulf of Alaska and Aleutian surveys use a post-tow criterion of a rapid change in the inclinometer from 40 to 60 degrees for assessing transition of net on (start of tow) or off the bottom (end of tow). Touchdown-Start of Tow criterion is not indicated in the protocols of the other three Science Centers. It is critical that these criteria are standardized.

Recommendation: *See trawl instrumentation section below.*

3. Tow speed

Standardized trawling speeds are indicated by all Science Centers. Recent advances in instrumentation and communication have led to the development of Differential Global Positioning Systems (DGPS) systems, which rival traditional Doppler speed-logs aboard vessels for accuracy in estimating speed over ground. All Science Centers mention DGPS, and some also mention having Doppler speed logs. It is my experience that DGPS and Doppler speed logs do not always agree, becoming more variable when seas are rough. In the NEFSC manual, it indicates that one vessel has both, and the second vessel has ‘several’ speed units. Here the manual instructs the Fishing Party Chief to “utilize all the speed instruments, but be aware of each of their shortfalls (page 29).” I suspect that

meeting this standard would be challenging to the Fishing Party Chief and bridge staff, and is a poor example of standardizing a critical protocol.

Recommendation 4: *Determine which speed instrument is the most accurate, choose it as the standard and indicate it in the manual.*

If the standard instrument chosen is a DGPS, the comments by NWFSC to minimize the sometimes erratic readings of that instrument should be accentuated. The NWFSC manual (page 8) notes that GPS update rates may be due to the speed at which the antenna is rolling towards and away from the satellites. The manual suggests changing the filter rate to every 10 seconds, where possible. At-sea experiments should be set up to determine the optimum filter rate, which rate would then become the standard in the manual.

Quality Controlling the tow speed: Koeller (1991) compared post trip recordings of towing speeds against the standard towing speed during several Nova Scotia surveys, and found a wide discrepancy over 30 minutes. After introducing a protocol for bridge officers to record on special deck sheets the trawling speeds every five minutes and make continuous adjustments to achieve the target tow speed, the amount of variability in tow speeds decreased substantially. Some Science Centers indicate that tow speeds are logged on a computer, one maybe by hand (SEFSC). How is Quality Control maintained thus?

Recommendation 5: *Given the critical importance of maintaining a standardized speed, all Science Centers should set up a routine in which the bridge staff constantly checks the vessel speed during the tow.*

4. Cessation of fishing activities (NEW)

Only one Science Center, NEFSC, addressed this critical issue. In heavy winds or swells, besides being a safety issue for those on deck, the performance of the fishing gear is seriously affected (variance in the door-spread will indicate this), as is catchability (Anon 1992). NEFSC has identified that fishing activities usually cease when sustained winds of

35 knots are reached. Resumption of fishing activity should also be related to both wind and also sea state; i.e. winds below 35 knots and swells less than xx meters. Wind speeds could drop, but heavy swells will affect gear performance and safety on deck.

Recommendation 6: All Science Centers should develop a standard protocol for the cessation and resumption of fishing activities, and have that protocol listed in their manuals.

5. *Scope ratios:*

Two of the four Science Centers, AFSC and NEFSC, have scope ratio tables listed with appropriate protocols for their use. NWFSC leaves it up to the captains of its four charter vessels, and SWFSC does not mention the topic. Captains of NWFSC charters (and presumably the fishing mate when the captain is off watch) use a rough rule of thumb in setting scopes. Net mensuration instruments are used to monitor gear performance and adjustments to the amount of trawl warp out until the gear becomes stable. With four charter vessels each carrying two watches, there are eight possible combinations of some form of scope ratio used in these surveys. Inadequate scope ratios cause poor door contact/stability, sand cloud generation, and bottom contact by lower bridles and footgear. Correct scope ratios result in stable trawl doors giving maximum spread without compromising bottom contact of the footgear/ground-gear, desired trawl opening and fish herding and selectivity/catchability of the trawl (Engås 1994). To maintain constant catching efficiency door spread, mouth opening and bottom contact (together with towing speed) must be consistent between tows and within a tow. The NWFSC manual states that the captain will adjust his warp when the net is on the bottom until the gear is stable. This could take up a large time portion of the standard 15-minute tow, especially in deep water, thereby negating the constant catching assumption.

Recommendation 7: Standardized tables of scope ratios, i.e. amount of warp out at each depth, should be experimentally derived for NWFSC and SFSC trawls for all fishing depths and recorded in their manuals. The scope ratios of all Science Centers should be

expanded to cover the amount of warp out for every depth surveyed in 1- meter intervals, as illustrated by NEFSC.

6. *Trawl instrumentation (NEW)*

All Science Centers use trawl instrumentation to measure performance and geometry of the trawl either actively by net mensuration equipment or during post tow analysis by examining bottom contact sensors (BCS) and bathythermographs (TDRs). BCS and TDRs can yield information on when the net was on-bottom (start and end of tows) and can be used to verify tow duration and tow distance. With the exception of SWFSC, which uses a headline mounted scanning sonar that gives a limited amount of information on the trawl opening and bottom contact, the other three Centers use sophisticated acoustic instrumentation. However, there are varying amounts of information from all four Centers on standardized attachment procedures and hardware, location sites, use of safety lines, and special netting pockets used to hold the sensors. Only the NWFSC shows location of sensors on the headline of its float attachment diagram. NWFSC and NEFSC provide the most details on the placement of their mensuration sensors, bottom contact sensors (NWFSC only), and TDR (not used by NEFSC). ASFC gives no information for its trawl specifications but does show the attachment site for wingspread and bottom contact sensors on its Survey Trawl Checklist. SWFSC mentions location of sonar, but it doesn't use TDRs or bottom contact sensors.

Recommendation 8: *The mounting of mensuration equipment is known to be critical to the quality of data received. Given the importance of various instruments being attached to the trawl to monitor trawl performance and geometry and oceanographic parameters, all manuals should be updated to show standardized procedures for attachment including hardware, location sites, use of safety lines, and special netting pockets.*

Given the aforementioned importance of door stability and its effect on swept area and catchability, it is surprising that no Center is using its net mensuration equipment to measure door spread on a tow-by-tow basis (NEFSC checks door spread initially and after every 50 tows). The 1992 ICES report on the sources of variability of the GOV

survey trawl states that, at a minimum, the door-spread, headline height, and towing speed should be measured to ensure that the net has normal geometry and is on the bottom. Of course, wingspread and speed through the water should also be measured if additional sensors are available. I have monitored a trawl where one trawl door has fallen over during the last half of a 30-minute tow without a detectable difference in wingspread.

Recommendation 9: *Given the importance of door stability, all surveys by the four Science Centers should use spread sensors on their trawl doors to monitor their performance at each fishing station. Standardized procedures for attachment should be included in the manual.*

Use of mensuration data (also see Tow duration above)

With the exception of SWFSC, all other Science Centers use Simrad ITI net mensuration instrumentation to monitor the trawl geometry and performance in real time and bottom contact sensors (BCS) to monitor post-fishing-set contact of the footgear. SWFSC uses a trawl mounted scanning sonar to measure bottom contact and trawl mouth opening. ASFC and NWFSC also use a headline mounted TDR which can provide information on touchdown and liftoff of the net, hence tow duration of the gear. All data are recorded by computer (ASFC, NWFSC, NEFSC) or by hand (SWFSC). However, there does not seem to be any standardized procedure on how this data is used.

Post analysis of all three instruments after each fishing set is indicated by NWFSC, but no information is available on how the data is used. NEFSC mentions how the data is used during fishing and post analysis of survey sets. SWFSC uses the sonar information during fishing to establish touchdown, but it doesn't define the touchdown criterion. AFSC apparently uses the information differently depending on the survey. For instance, the Center uses net height information to determine touchdown for Gulf of Alaska and Aleutian surveys, utilizing all instruments (ITI, BCS and TDR) to adjust towing times in post analysis of each fishing set. Traces of bottom contact sensors are used to determine

start and end of tow times. However, this consistency in usage of instrumentation and data does not apply to the other two surveys for which the Center is responsible. In the Eastern Bering Sea Shelf survey, the AFSC uses all three sets of instruments (ITI, BCS and TDRs), without elaboration of specific application, to determine a successful tow in post analysis of each fishing set. AFSC does appear to use a touchdown and start of tow criteria for fishing. Similarly, in the EBS Upper Slope survey, no touchdown and start of tow criterion is given. . In addition, during the EBS Upper Slope survey, the AFSC carries out a post analysis of all three sets of instruments (ITI, BCS and TDRs) to determine whether or not the fishing tow was successful. In the EBS Upper Slope survey section (page 19), the AFSC manual states that ‘interpretation of criteria used for determining good and bad performance can vary among Field Party Chiefs based on knowledge and personal experience with the particular net, bottom conditions, current and sea state’. Presumably that conclusion applies to the other three surveys carried out by AFSC. The manual then lists minimal criteria related to the data from the 3 sets of instruments that could help the Fishing Party Chiefs determine a successful tow.

The primary objective in monitoring trawl performance is to determine when the trawl has reached the bottom on deployment and initiate the start of the tow, and to confirm that the gear is operating in a prescribed manner with relatively constant capture efficiency (Anon 1992).

Recommendation 10: *Standardized protocols for determining trawl touchdown/bottom contact for initializing the start of tow are needed. Standardized protocols for post analysis of precise tows times, on-bottom contact, and geometry for a successful tow are also needed, based on information gathered from these instruments. Note: SWFSC should consider upgrading its mensuration equipment to the standard of the other three Science Centers.*

7. *Criteria for determining a successful tow.*

There are net damage and depth criteria provided by most Centers, but there is little information on how gear performance data may be used to determine if a tow was

successful. Specific recommendations in the *trawl mensuration section above* apply to this comment.

PROTOCOL 4: TRAWL CONSTRUCTION AND REPAIR

Only one (SWFSC) of the four Science Centers indicated that a net manufacturer constructs their trawls. No details on how nets or trawl components are procured are given, i.e. sole source, tender process, bought whole, or in sections, or both. I assume that all trawl and components are bought through the government tendering process, and that many of the trawl nets are built from components, i.e. precut panels, bales of twine, hardware by NMFS/NOAA staff in net lofts at their (3/4) institutes.

I note that, with the exception of NEFSC (which has its own research vessels and government-paid crews), all other Centers rely on charter vessels and commercial crews. Both the AFSC and NWFSC have to deal with crews from four commercial fishing vessels, and the SWFSC employs one commercial crew. Commercial crews are constantly enhancing their fishing trawls to maximize harvest efficiency and often have difficulty grasping the concept of standardized efficiency. At least two of the Science Centers, NWFSC and SWFSC, have bales of twine and only certain pre-cut panels listed in their inventories of survey supplies which would imply that fishing crews cut the other panels out of the bales of twine for repairs at sea. These procedures are fine for commercial operations but not for scientific surveys where standardized of construction is critical.

Net drawings:

E.S. Strange, a net designer at the Marine Laboratory in Aberdeen in 1978, clearly articulated the requirements for standardization when he wrote that:

“The purpose of the net drawing is to recommend to net makers sufficient information to allow them to construct identical nets from the same drawing, and to users of the net the recommended way to rig it and restore it to its specification should it be damaged during its working life. When executing the net drawing therefore, the draughtsman should aim to produce a document that provides a complete specification for the construction of the net and any non-standard associated items. It should present all information relating to shape, sizes, materials and construction, concisely and without ambiguity, using recognized conventions, symbols and nomenclature (Strange 1978).”

The National Trawl Survey Standardization Workshop guidelines (see page 8) for Protocol 4 state that the trawl construction plans “must include engineering drawings of the net, doors, and riggings with a level of detail at least as specific as that in the ICES recommended standard (ICES C.M. 1989/B44 Report of the Study Group on Net Drawing).” I have examined the 1989 ICES Report, and note that the ICES standard construction plans do not deal with trawl wires, footgear and trawl doors riggings. Hence, the ICES report cannot serve as a standard to cover all items in the protocol instruction for trawl construction plans. The report gives specifications only for the trawl net, and includes the netting material and mounting ropes descriptions. The 1992 GOV Subgroup Report of the ICES Fish Technology and Fish Behavior Working Group used the ICES Net Drawing standard to redraw the net plans for the GOV survey trawl used in the International Bottom Trawl Surveys of the North Sea (Anon 1992). None of the included Science Center net plans meet the 1989 ICES standard, although the ASFC plan is probably the closest.

As Strange (1978) points out “the purpose of the net drawing is to recommend to net makers sufficient information to allow them to construct identical nets from the same drawing”. The question is: if five manufactures were given the net plans of each Center, could they each produce five identical trawls? The answer is probably no as the level of detail required to produce identical trawls is not included in many of Center net plans, and important information about, material, twine size, mesh definition (stretch lengths), joining rows, how panels are selvaged together, and whether panel widths contain

selvedges meshes, is often missing. Frame lines/ropes should be on the same diagram, and panel definitions are needed as specified in the ICES report (Anon 1989). There is no standardization of trawl door description and riggings, and footgear specifications and descriptions are often vague. A national standard is needed to cover doors, footgear, and wires/cables riggings (discussed below).

Only NEFSC follows the international accepted definition of a stretched mesh, knot center to knot center. To be fair, the five putative manufacturers could do a reasonable job of producing identical trawls for some of the Centers, if they were also given the detail text describing the specifications for construction that are found in most manuals which the reviewer suspects is the practice for construction and repairs. But as noted below, there are still major discrepancies in many of these specifications.

Comment: Detailed trawl construction plans are preferred over incomplete construction plans when seeking bids from manufacturers, building trawls in the net loft, and repairing and checking trawl construction at sea.

Trawl doors

The NEFSC uses 450 kg Euronete doors (attachment points not shown), according to its drawings on page 40; however, on page 6, the same doors are called Portuguese polyvalent doors, and no dimensions for the doors are listed, i.e. length & width or surface area. The SWFSC use NET Systems Vented-V, for which it provides all dimensions in the trawl parts list covering air-weight (2250 lbs) and water-weight and surface area on page 19; the schematic on page 7 describes length and width and an air-weight of 2300 lbs (not 2250 lbs. as in the text). The NWFSC uses 5' x 7' all steel Vee Doors, but does not list weight or surface area. The AFSC uses two types of trawl doors: a 6' x 9' V door listing a weight of 2200 lbs; and a 6' x 9' V door listing a weight of 1800 lbs, indicating that the same door type can have different weights. I would suggest that the specifications of each Center carry the manufacture's name of the trawl door to be more specific. In the market place, more than one manufacturer could supply a 6' x 9' V-

door weighing 2200 lbs; however, these doors will not necessarily perform equally due to differences in the location of the centre of gravity. Walsh and McCallum (1995) reported that 4.3 square meter, 1400 kg cambered oval, single slot polyvalent doors made by two different companies (alike in all visual aspects) differed in average door spreads by 24% and average wing spread by 15%, resulting in one door type being unstable in shallow water (<100 m).

Recommendation 11: All door specifications should list the manufacture's name, weight, dimensions (surface area and/or length and width) and style: e.g. Morgere 4.3m² 1400 kg cambered oval, single slot polyvalent doors. Attachment points and all other riggings and material should be well labeled in all diagrams (see ASFC for an example).

Weights

Components for frame ropes and all footgear/ground-gear in the trawl specifications for each Center are missing. These weights are critical since they can vary tremendously from manufacturers/suppliers, particularly in the weights of the main trawl warps, rigging wires, chains and footgear components. The differences in the weight of footgear components can affect the bottom contact and hence selectivity of the footgear. It would also be prudent to indicate minimum breaking strains (MBS) of all wires, cables, chains and ropes since they also differ. Additionally, minimum safe working loads (SWL) of components such as G-hooks shackles, etc., are desirable. Use of both MBS and SWL will minimize delays and safety concerns.

Recommendation 12: All components of the frame ropes, wires, cables, chains and ground-gear should be standardized to show length, diameter, material, class and weight in the parts list and on any net plans. Trawl parts list should also show MBS and SWL.

Floats

Buoyancies are listed as unknown for the NEFSC trawl specifications for Standard 36 Bottom Trawl, but are listed for its flat net (listed at 8 lb each on page 46, but later listed

as uncertain on page 49). McCallum and Walsh (1995) estimated that using an incomplete float specification of 8 inch and 1000m depth rating for floats available from different suppliers could result in floats with buoyancy varying up to 12%, or the equivalent of 13 extra floats on a 100 ft headline. The difference would change the opening of the trawl and bias swept area estimates. Substituting a different color would change the visibility of the trawl and fishes' reaction to it.

The distance apart and the number of floats should be specified and standardized. NWFSC uses a diagram but with no explanation on what numbers refer to (i.e. is it distance apart?). NEFSC specifies distance apart in detail, but AFSC and SFSC do not. NWFSC uses its float placement diagram to show where the head-rope sensors are located, but no other sensors are noted. Placement of mensuration sensors and bathythermograph equipment on the head-rope may increase the weight; if the weight is increased, floats should be used to compensate for the increase.

Recommendation 13: *All floats should specify diameter, depth rating, buoyancy and color. E.g. 8" diameter, 1400 m depth rating, buoyancy of 2.60 kg (seawater) & color yellow. The manufacturer's name could be added. Float arrangement (spacing and number per section) should be indicated in the manual and on the net plan.*

Frame Ropes: The ICES Net Drawing recommends that the net plan show the framing ropes with the following essential information: the linear density in kg perm, material composition, construction, and conditioning (Anon 1989). The total length of rope, and that part to which each individual netting section is attached, should also be shown. The ASFC manual does show some framing ropes in its net plans but there is no consistency across its four trawl construction plans. For example, the rib-lines and total length are shown in its 83/112 eastern trawl, and in the northeastern plans it shows brestlines and rib-lines on a separate diagram. There are no framing ropes indicated in the net plans of NWFSC, SFSC (length mentioned but diameter not listed in parts list) or NEFSC (rib-lines not mentioned anywhere).

Recommendation 14: All net plans should show frame ropes with the following information per section/join: length, diameter, weight (kg/100m), and material. E.g. 6.7m x 20mm ø combination wire (6 strand/steel core-54.4kg/100m) as specified in the 1989 ICES Study Group on Net Drawings.

Summary

Choosing the ICES 1989 net drawing report as a standard for net plans covering materials of the netting and frame-ropes is an acceptable start, but this report has no standards for rigging of wires, footgear, and trawl doors.

Recommendation 15: The Science Centers devised an acceptable national standard of net drawing that includes net plans, wire riggings, footgear and door specifications for all Science Centers to follow.

Comment: There are many institutes in ICES countries, as well as FAO, that should be consulted to help devise these standards. The 1989 Report of ICES Study Group on Net Drawing should remain the standard for the net plan section.

Quality Control in Survey Trawl Construction and Repair

Trawl manufacturers and suppliers of parts may interpret net plans with a commercial bias. Unlike commercial net plans, which require skilled subjective interpretation, and in some instances are purposely vague for reasons of patent-ownership, survey trawl standardization cannot succeed in the face of ambiguous or non-existing information. Procurement personnel, trawl manufacturers, survey crews, and scientific staff all require precise information to order materials to construct the trawls, repair the trawls, and check to see if the trawl meets standards for surveying. Unfortunately drafting of good specifications only solves half of the problem of variability in construction. The specification must be adhered to, and this adherence is difficult if construction practices vary between vessels, surveys, and regions.

Both the 1991 international workshop on trawl mensuration (Walsh et al., 1993) and the 1992 ICES report on the GOV (Anon 1992) recommended Quality Control Programs to cover all aspects of purchase, construction and repair. These programs should cover 1) internationally recognized standardized trawl plans; 2) a program to regulate and standardize procurement and construction of the trawl and its components and 3) a fishing gear checklist to ensure that trawl is built correctly before leaving port for the survey and after major repairs at sea according to the standardized trawl plans (for a detail example see McCallum and Walsh 1995).

Quality Control Program point #1: on international recognized standardized trawl plans

This was dealt with above, under net plans.

Quality Control Point # 2: a program to regulate and standardize procurement and construction of the trawl and its components.

There is little or no information on standards and tolerances used in procurement of whole nets or components or when nets are built on site (Centers). Fishing gear bought through tendering process is subjected to the distributor or manufacturer who may vary their supply of parts from order to order because of demands by the fishing industry for similar parts or mesh sizes. Likewise, the government official handling the tender may be more interested in saving money, than in the biologists' standardization program, i.e. price versus consistency. This system requires appropriate purchasing methods (e.g. sole source), good communication with distributors/manufacturers and purchasing department, a level of acceptable tolerances specified in a Quality Control Program, and training of all those responsible. A change from a distributor/manufacturer who has experience building a particular trawl and understands requirements and tolerances, could have significant impacts later in the process (e.g. resulting in a rejection of the product and wasted time). At the Northwest Atlantic Fisheries Center in Newfoundland, every component of the trawl is listed along with its technical description, specification of the quantity required to make one trawl, and the acceptable tolerance requirements on

specific dimensions (see McCallum and Walsh 1995). The trawl drawing on which the particular component is found and the part number it has been assigned is also listed. The part number becomes the most common reference used between ships crews, warehousing, purchasing department and manufacturers/suppliers. Tolerances assigned to key specifications of components form the basis for acceptance or rejection criteria used during quality control inspections before any supply order is accepted from manufacturers and distributors.

The NWFSC manual is the only one that mentions some guidelines in this regard: “minor variations in design and materials in accordance with accepted industry practice are acceptable if they are justified and described. Any alternative material must be provided by the vendor and accompanied by the manufacturer’s specifications demonstrating their suitability. Alterations in general panel shapes, dimensions or specified mesh sizes are not permissible.” Although this standard particularly addresses the quality control aspect of procurement, it is not detailed enough for comprehensive quality control.

Recommendation 16: *Science Centers should develop a quality control program regarding procurement of fishing gear supplies that includes a detail parts list and has stated tolerances on component specifications to maintain standardization of fishing gears.*

Quality Control Point # 3: a fishing gear checklist to ensure that trawl is built correctly before leaving port for the survey and after major repairs at sea according to # 1.

ASFC uses a one page Survey Trawl Checklist of overall rigging components to inspect and measure the gear prior to loading it aboard the survey vessel. The Center uses a Net Repair form covering only the net; however, the form also indicates that other “components potentially affected by at-sea repairs will be re-measured to confirm the trawl is meeting specifications.” The Fishing Party Chief oversees net repairs, however it does not say who inspects and measures the trawl before loading it aboard a vessel.

NWSFC uses a Net Repair form (not shown) to document repairs and is implementing a new at-sea repairs and a trawl-rigging checklist, which is being developed for 2003. The form is unclear as to who will do the inspections.

SWFSC uses a Repair Form covering repairs done mainly to the net that the crew fills out. It has developed a Trawl Checklist table that the fishing crew uses prior to cruises, to inspect rigging components of doors and bridles. Scientific staff is not involved in the inspections.

NEFSC uses a Checklist table covering attachments of frame-ropes, floats, and the proper attachment of net panels, footrope, and footgear components. This checklist is the only one that recommends the checking of mesh sizes and shape, but only periodically. Scientific staff uses the checklist to check the trawl before loading. The scientific staff also verifies repairs using a repair checklist.

The 1991 International Workshop Report on Survey Trawl Mensuration and the 1992 ICES report on the GOV recommended the use of Survey Trawl Checklists to ensure that specifications are maintained during construction and during at-sea repairs. A full check of all components should be carried out before leaving the dock and following major gear damage (the repair to the affected sections of the trawl should also be checked). Both documents illustrated ergonomically-designed drawings for use under different conditions, and they covered profile riggings, trawl body, frame ropes, and footgear. These diagrams may be adapted as a repair checklist. ASFC has designed its checklist in a similar manner but does not cover all of the details mentioned in the two international reports. If the scientific staff is checking only the rigging of the trawl, then there are no assurances that the mesh sizes are correct, panel widths are correct, the footgear component size and numbers are correct, the hanging ratios are correct, etc. Who ensures that net panels cut out of bales of twine on the NFSC and SFSC are the correct length and shape? These practices can result in variations to the construction and repair of the standard trawl. It is suggested that replacement of net panels at-sea be done solely from Quality Control inspected pre-cut panels in all surveys to maintain standardization.

Recommendation 17: *The Science Centers should develop a national standard checklist (one which includes mesh materials) that can be used prior to departure to ensure the standard trawls and components are identical in all respects to the net plans.*

Comment: *The national standard checklist may be adapted to cover net repairs and should be easy to use on deck. The checklist should be used by the scientific staff together with the vessel crew to ensure standardization of construction prior to departure, and by the scientific staff and crews for QC repairs. If manufactured webbing is purchased in bulk to construct in-house panels, these panels must meet the specifications of the QC. The use of webbing to cut out panels for at-sea replacement is discouraged because of the likelihood of substandard construction under such difficult working environment.*

COMMENTS ON WORKSHOP RECOMMENDATIONS

1. WIRE ROPE SPECIFICATIONS AND MEASUREMENT STANDARDS

Comment: *I fully agree with the report's findings, and believe that these standards should be a task of the next group meeting.*

2. SURVEY STANDARDIZATION WORKING GROUP

Comment: *I fully agree. This working group can develop and/or review many of the recommendations listed in this review, particularly focusing on a national Quality Control Program of standardization in procurement, construction, and repairs. The group should consider expanding its membership to include members of such groups as the fishing industry, and gear suppliers/manufacturers.*

3. TRAINING IN CONSTRUCTION AND REPAIR VERIFICATION

Comment: *I fully support this initiative. The implementation of rigid specifications, tolerances, and quality control will be successful only if all participants in the process claim and share ownership. Most scientific staff is not trained in fishing technology, nor are the fishing crews and vessel staff trained in the rigorous ways of surveying and*

sampling methodology. Training courses should be designed for scientific staff and research vessel crews, with the former concentrating on fundamentals of fishing gear technology, trawl identification, fish behavior, trawl instrumentation and fishing gear performance, and the latter on fishing gear performance, use of trawl instrumentation and sampling methodology used during surveys and fish behavior.

The attitude and knowledge of scientific, bridge, and fishing staff during a survey can significantly influence results.

CONCLUSIONS

The impetus for this workshop stemmed from the 2002 survey trawl warp issue at NEFSC in Woods Hole, MA. Two of the five protocols deal with this issue, as well as one out of three recommendations that are made in the workshop for future work. The Science Centers have adapted many of the protocols to their manuals in the updated version, and it represents a tremendous amount of hard work on the part of many staffers over a short time period since the national workshop in November 2002.

I was asked to ‘specifically address whether the protocols ensure that all aspects of preparation for trawl surveys and trawl survey procedures are consistent and in keeping from one survey to the next. My overall conclusion is that although the new wire protocols in each manual for measurement and standardization are clear, concise, timely, and have been adapted, the protocols represent only a small component of the survey standardization process. A weakness of the Science Center manuals has been the adaptation of standardized protocols in ‘Survey Operational Procedures’ and ‘Trawl Construction and Repairs’. However, it is noteworthy that recommendations 2 and 3 of the workshop allow a forum whereby many of the seventeen recommendations made in this review may be addressed. These workshop recommendations also illustrate that this standardization program is a long-term process, and one that needs to be periodically reviewed and updated.

LITERATURE CITED

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Walsh, S.J and B.R McCallum 1995. Performance of the Campelen 1800 shrimp trawl during the 1995 Northwest Atlantic Fisheries Centre autumn groundfish survey. NAFO Scientific Council Studies, 29:105-116.

APPENDIX I: Background material provided for the independent review

Trawl Survey Protocol Development Team (G. Stauffer). 2002. NOAA Protocols for Groundfish Bottom Trawl Surveys of the Nation's Fishery Resources. AFSC/NMFS/NOAA/DOC.

APPENDIX II: STATEMENT OF WORK

Consulting Agreement between the University of Miami and Dr. Steve Walsh

January 7, 2003

Background

Trawl surveys conducted by or for National Oceanic and Atmospheric Administration (NOAA) Fisheries provide crucial fishery-independent data for assessing the status of many federally managed stocks. Therefore, the credibility of these surveys, including the credibility of the methods used to conduct them, is of great importance to the management process. In late summer 2002, it was brought to NOAA's attention that the trawl warps used to deploy the nets in the trawl surveys conducted by the NOAA Ship *Albatross IV* between the winter of 2000 and spring of 2002 were not properly measured and marked, which caused the nets to be towed with more cable out on one side than on the other. The discrepancy ranged between 1 inch at 100-m cable out to nearly 6 feet at 300-m cable out. This mis-alignment may have affected net configuration and net functioning, which could have affected the resulting data.

Because of the above problem, Vice Admiral (Ret.) Conrad C. Lautenbacher, Jr., Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator, released a memorandum on September 16, 2002, which outlined five points to be addressed. Points 3 and 5 are relevant to this peer review, and are reproduced below.

“(3) The Director, OMAO [Office of Marine and Aviation Operations] and the AA [Assistant Administrator] for NOAA Fisheries will review current protocols and directives regarding trawl survey operations, determine what changes are needed, and publish a new protocol. The objective of this effort is to ensure that all aspects of preparation for trawl surveys and trawl survey procedures are consistent and in keeping with the highest quality standards to provide for survey accuracy and consistency from one survey to the next. Action to be completed within 90 days [i.e., by December 16, 2002].

“(5) NOAA Fisheries, in coordination with OMAO will convene an independent panel (non-federal government employees) to review our revised trawl survey procedures and provide recommendations for improvement. Final report will be made public upon completion of this comprehensive review. Action to be completed within 180 days [i.e., by ca. March 16, 2003].”

This independent peer review will cover the protocol document prepared under Point 3, and will fulfill the independent review requirement of Point 5. The trawl protocol document was developed in accordance with Point 3 of Admiral Lautenbacher's December 16, 2002 memo. Preparation of the document was coordinated by the Alaska

Fisheries Science Center, and involved personnel from all the NOAA Fisheries Science Centers, the Office of Science and Technology, and OMAO.

Specific

The consultant will be provided a copy of the protocol document and shall require a maximum of five days to read the document and to produce a written report. No travel shall be required for the review, and no consensus report shall be accepted.

The written report shall consist of an executive summary of findings and recommendations, and a main body consisting of background; description of review activities; and findings and recommendations for improvement. The report shall also include as separate appendices all literature cited in the review, and a copy of this statement of work.

In keeping with the requirements in Point 3 of Admiral Lautenbacher's memorandum, the consultant shall specifically address whether the protocols ensure that all aspects of preparation for trawl surveys and trawl survey procedures are consistent and in keeping with the highest quality standards to provide for survey accuracy and consistency from one survey to the next. If problems are identified, the consultant shall provide specific recommendations to address each problem.

The consultant shall be responsible for the following tasks:

1. Reading the trawl protocol document, which will be provided in advance;
2. No later than January 31, 2003, submit the written report¹ (see Annex I) addressed to the "University of Miami Independent System for Peer Review," and sent to Dr. David Die, via email to ddie@rsmas.miami.edu, and to Mr. Manoj Shrivani, via email to mshrivani@rsmas.miami.edu.

¹ The written report will undergo an internal CIE review before it is considered final. After completion, the CIE will create a PDF version of the written report that will be submitted to NMFS and the consultant.

ANNEX I: REPORT GENERATION AND PROCEDURAL ITEMS

1. The report should be prefaced with an executive summary of findings and/or recommendations.
2. The main body of the report should consist of a background, description of review activities, summary of findings, conclusions/recommendations, and references.
3. The report should also include as separate appendices the bibliography of all materials provided and a copy of the statement of work.